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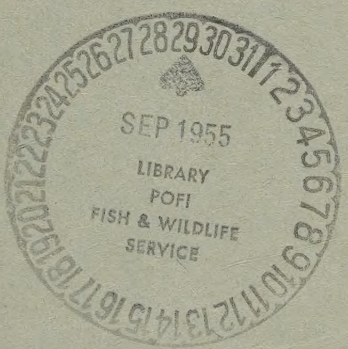
Continuous Oxygen Recording in Seawater

By
Ernst Føyn



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Continuous Oxygen Recording in Seawater

Continuous recording of the density of seawater by means of the densigraph (FØYN, 1953) has very often shown extraordinarily sharp discontinuity layers in the Oslofjord.

As it was expected that the oxygen content would vary in the same way, we started searching for a method which could continuously register the oxygen content in the water from the surface to the bottom.

Two methods could be followed. The first involves using the polarographic method with a dropping mercury electrode and an applied voltage. In spite of many attempts we never succeeded in building an apparatus using these principles which was suitable for work on board ships.

The second method involves the principles found by TØDT. If electrodes of a noble and a base metal, such as platinum and zinc, are placed in water and combined with a microammeter, initially it will be possible to register an electric current. The strength of this current depends upon the oxygen content of the water. If the water between the electrodes flows with a certain velocity, the apparatus will register the oxygen content in the water, but in stagnant water the electric current will soon die out.

WALDEMAR OHLE succeeded in building a continuous oxygen recorder according to these principle (OHLE, 1953). Compared with measurements made by the usual analytical techniques, the «Sauerstoff Lot» by OHLE gave very accurate determinations.

In order to keep the water moving with the right velocity during the measurements it was necessary either to combine the electrodes with by a mechanically driven propeller or to move the apparatus up and down in small oscillations by hand.

For some tasks, such as determinations of the oxygen content near the bottom, through sharp discontinuity layers, or at greater depths perhaps it may be an advantage to use a method which is independent of the flow of water between the electrodes. Such an apparatus was constructed in our laboratory shortly before we received the publication by OHLE.

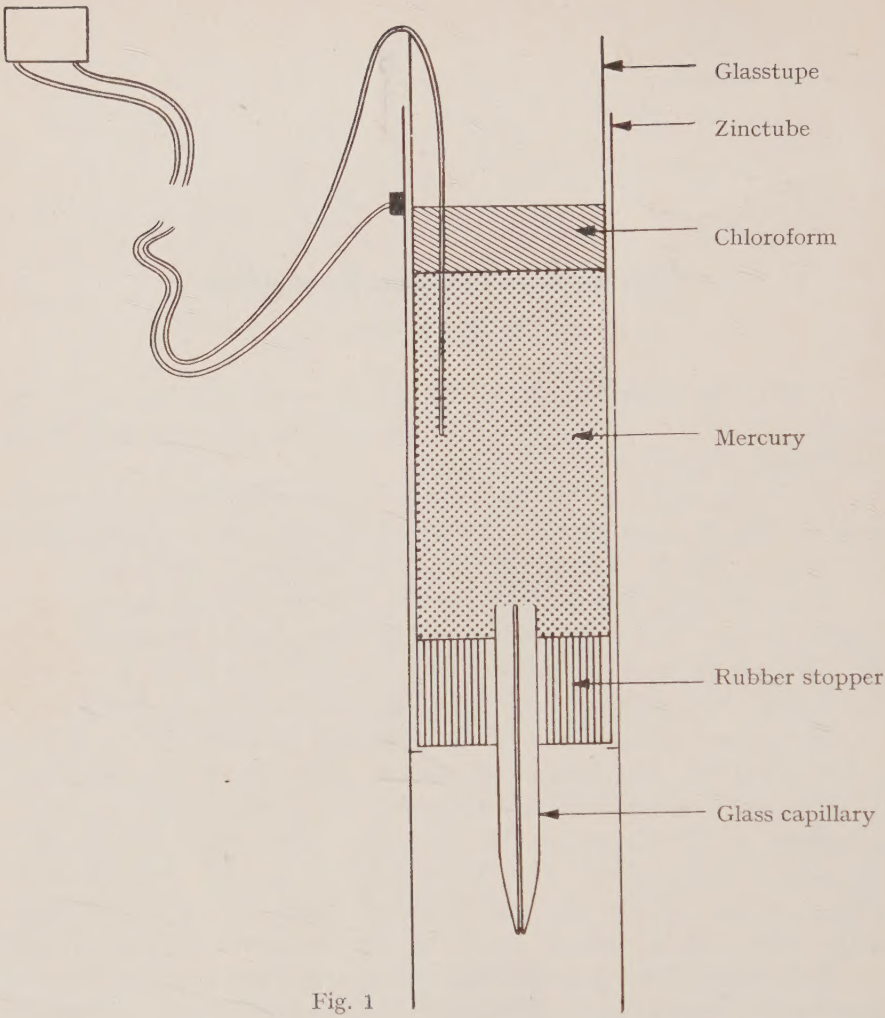

Fig. 1

The apparatus is built according to the principles mentioned above, but with different electrodes. The first one is a zinc electrode as in the apparatus of OHLE. The second electrode is a dropping mercury electrode similar to the electrodes used in polarography, however, without an applied voltage. These electrode-couples give a constant electric current in stagnant as well as in moving waters.

This apparatus has been in use for about two years and has given many valuable results. It is rapid and simple to manage, and can be built in any laboratory in a few hours.

In Figure 1 the apparatus is drawn full scale. It consists of a glass-tube with a rubber stopper in the bottom. A thin glass capillary, drawn

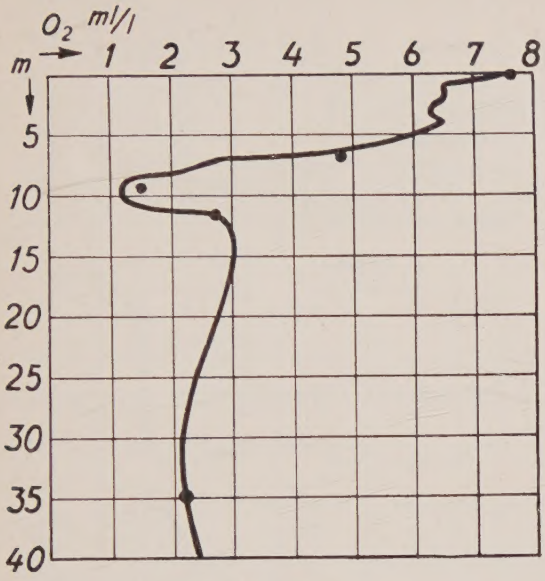

Fig. 2. Oxygen Lysakerfjord 11/8—54.

● Ordinary methode
—— Oxygen recording

Table I.
Lysakerfjord 11/8—54.
Oxygen recording.

250 units = 100 microampere

m	units read
0	175
1	150
2	150
3	145
4	150
5	135
6	120
7	75
8	55
8.5	40
9	30
10	30
11	45
11.5	55
12	65
13	70
20	66
25	57
30	52
35	54
40	60

out to a point, goes through the center of the rubber stopper. The glasstube is three-quarters filled with mercury, which drops rapidly out of the capillary. The glasstube with the mercury represents the first of the electrodes; this is placed in an open tube of zinc metal, the second electrode. The two electrodes are combined with a microammeter on deck by means of insulated electric cables. A few milliliters of chloroform are poured into the glasstube in order to electrically insulate the surface of the mercury from the water. The apparatus is fixed below the lead and lowered with the hydrographic cable, while the electric cable is paid by hand. The variation of the electric current is read on the microammeter. One or two usual oxygen determinations should be taken each time for calibration. The mercury, which should be perfectly clean, can be collected in a cup hanging below the electrodes and may be used again.

One example from our determinations is given in the tables I and II and figures 2 and 3.

Table II.
Lysakerfjord 11/8 —54.
Ordinary methods.

m	temp.	S $^{0}/_{00}$	O_2 ml/l
0	18.5	16.46	7.60
7	16.4	19.52	4.80
9.5	13.0	25.48	1.48
12.0	11.0	27.47	2.72
35.0	7.0	33.06	2.12

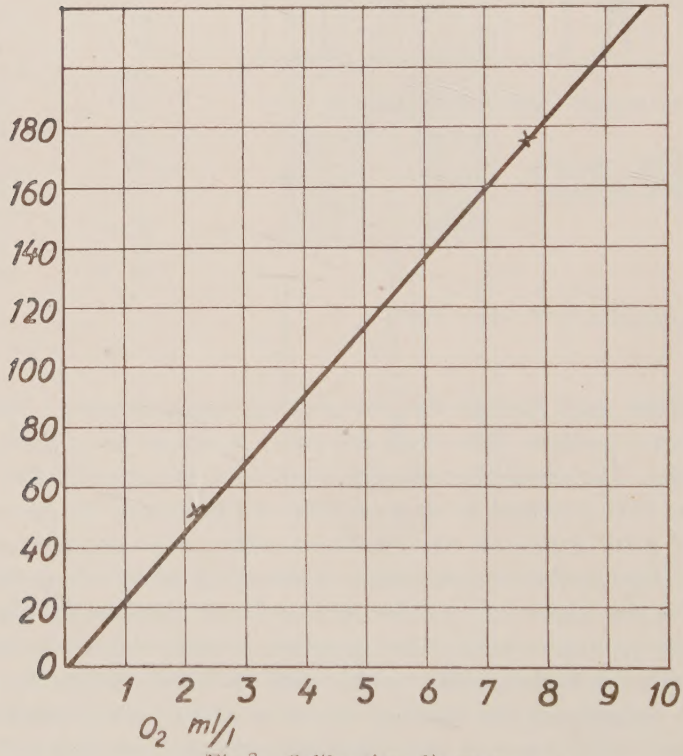

Fig 3. Calibration diagram

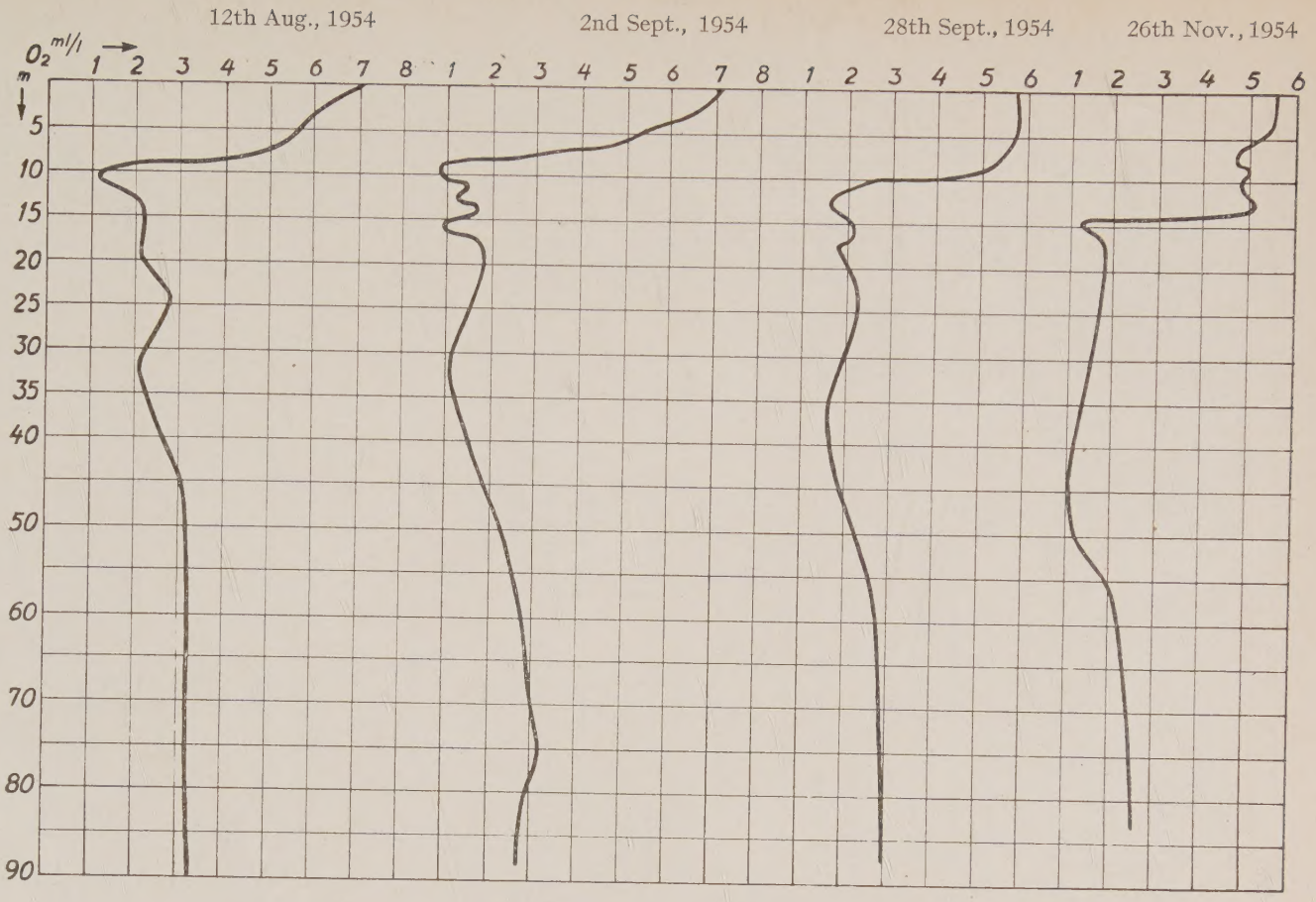

Fig. 4. Oxygen recording St.Bonnefjord during the autumn 1954.

Summary of the results and experiences obtained during the work with the oxygen recorder.

The apparatus is very simple to build and use, and it works rapidly. It is possible by means of this apparature to take continuous readings of the variations of oxygen content in the water downward from the surface. The readings give a picture which is available immediately, and which may be useful for the marine biologist working at sea.

For hydrographic work it may be of interest that the recorder indicates the depths where the oxygen content changes rapidly, which may be important in deciding where to take additional observations.

With a few determinations of the oxygen content by the usual method it is possible to obtain a linear calibration diagram (see Fig. 3) by means of which the oxygen content at various depths can be determined with fairly good accuracy. It is recommended that anyone who starts using the apparatus should at the beginning make usual Winkler determinations of the oxygen content whenever the oxygen recorder is used. This is necessary because the ammeter values are dependent on the purity of the mercury and on the speed of the falling drops. The calibration curve, therefore, will not always go through zero.

In water with sharp discontinuity layers it should never be possible to determine salinity and oxygen content of such layers by means of the usual methods with any accuracy at all. This is because the water sampler itself is so long that it collects water of greatly varying properties. In such discontinuity layers only continuous recording can give the correct picture.

Fig. 4 gives examples of curves obtained by the oxygen recorder.

Acknowledgement.

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Universitetets biologiske lab., Oslo.

Desember 1954. *Ernst Føyn.*